Subterranean Biology 51: 49–59 (2025)
doi: 10.3897/subtbiol.51.151034
https://subtbiol.pensoft.net

SHORT COMMUNICATION

A peer-reviewed open-access journal
Subterranean Biology
Published by The International Society for Subterranean Biology

On the troglobitic velvet worm *Speleoperipatus spelaeus* Peck, 1975 (Onychophora, Peripatidae): assessing the status of a Critically Endangered Jamaican invertebrate

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Academic editor: Fabio Stoch | Received 21 February 2025 | Accepted 6 March 2025 | Published 24 March 2025

https://zoobank.org/A8BB6BD3-FE66-4797-9C92-34E8205262FC

Citation: Giribet G, Anilkumar PA, Goodwin A, Stewart RS, Watkis CA, Whyte D, Hormiga G (2025) On the troglobitic velvet worm *Speleoperipatus spelaeus* Peck, 1975 (Onychophora, Peripatidae): assessing the status of a Critically Endangered Jamaican invertebrate. Subterranean Biology 51: 49–59. https://doi.org/10.3897/subtbiol.51.151034

Abstract

The velvet worm *Speleoperipatus spelaeus* Peck, 1975 is one of the rarest velvet worm species reported, as it is only known from its type locality, Pedro Great Cave, Clarendon Parish, Jamaica. The type material of the species, the only four specimens available in known scientific collections, was obtained in the early 1970's, and since then, no additional specimens have been available for research. More recently, observations of three probably conspecific specimens by the Jamaican Caves Organisation, not collected, have been made in a different location, Swansea Cave, Saint Catherine Parish. Here we report and document five specimens of this rare species from the type locality, Pedro Great Cave, as well as some observations about their behavior. Placing this species in a phylogenetic context should be attempted in the future, to better understand the significance of *Speleoperipatus spelaeus* and its evolutionary origins, its relationship to the Swansea Cave specimens, and to determine what are its closest relatives and whether those are other Jamaican species or velvet worms from other geographical areas.

Keywords

Cave biogeography, Jamaican caves, Jamaican endemics, Onychophora, Terrestrial invertebrates, troglobiont

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Introduction

Jamaica is the third largest island in the Caribbean, with limestone of Eocene age exposed over two thirds of the island, forming extensive karst systems (Brown and Ford 1973) with numerous caves and sinkholes (Fincham 1997) that are home to numerous troglobitic endemics. After Cuba, Jamaica has the richest known diversity of cave faunas on any island in the West Indies (Peck 1992). Velvet worms (the members of the phylum Onychophora) are mysterious terrestrial invertebrates best known for their velvety appearance and their unique mode of prey capture by shooting a stream of glue from their oral papillae (Guilding 1826; Read and Hughes 1987) (see Fig. 1). From the 232 currently accepted extant species (Oliveira 2023), many are considered short-range endemics (Harvey 2002), and only two are restricted to cave environments. Due to their restricted habitats, poor dispersal ability, and limited distribution, onychophorans have emerged as a model invertebrate taxon for conservation priority (Mesibov and Ruhberg 1991; New 1995; Hamer et al. 1997; Sosa-Bartuano et al. 2018; Trewick et al. 2018). Indeed, one of the few invertebrates supposedly extinct in a continental landmass is the Lion's Hill velvet worm, *Peripatopsis leonina* Purcell, 1899, from the Cape Peninsula in South Africa. This species has no known records subsequent to the early 1900's, as it inhabited an area that underwent substantial habitat change, including the development of recreational areas, the planting of pine forests, and the building of houses (Hamer et al. 1997).

Amongst the least known velvet worms are those that inhabit extreme environments, especially cave systems. These few velvet worm species may display typical troglobitic adaptations, specifically a lack of pigmentation, blindness, and a certain degree of appendage elongation. Tasmania has a non-troglobitic species that is blind and depigmented, *Leucopatus anophthalmus* (Ruhberg, Mesibov, Briscoe & Tait, 1991), a species of conservation interest (Mesibov and Ruhberg 1991). Blindness is also characteristic of the Indian species *Typhloperipatus williamsoni* (Kemp, 1914) from the foothills of the Himalayas. The South African *Opisthopatus camdebooi* Barnes & Daniels, 2022 is lightly pigmented, a near-surface-dwelling velvet worm species with a sunken and unpigmented eye, probably associated with an underground mode of life (Barnes and Daniels 2022). There is also a velvet worm species inhabiting a lava tube cave on the island of Santa Cruz, Galapagos, but this species has no obvious troglomorphic features, and it has also been found on surface environments (Espinasa et al. 2015). This unnamed species is closely related to *Oroperipatus eisenii* (Wheeler, 1898) from Mexico (Giribet et al. 2018), and how it arrived to Galapagos remains unanswered.

Only two true troglobiont velvet worm species are known, one for each of the two velvet worm families, Peripatidae and Peripatopsidae. Within the latter family, *Peripatopsis alba* Lawrence, 1931, was described based on two specimens collected in Table Mountain caves (Lawrence 1931), more specifically the Wynberg and Bat Cave systems of Table Mountain (Sharratt et al. 2000; Giribet et al. 2013; Lopes Ferreira et

al. 2020; Barnes and Daniels 2022), and the species has been found only a few times after its original discovery, including once by one of the authors of this note (GG). *Peripatopsis alba* is considered an exceptionally rare species and is classified as Vulnerable (V) on the IUCN Red List, as it occupies deep sections of the two cave systems on the Cape Peninsula, where it can be found on or under rocks.

Jamaica, like many other Antillean islands, is home to velvet worms, five in this case, all belonging to family Peripatidae, which Gosse (1851) considered "the greatest curiosity" of his many discoveries in his Naturalist's Soujourn in Jamaica. But the first Jamaican velvet worm was not formally described for nearly half a century, when *Peripatus jamaicensis* Grabham & Cockerell, 1892 (now *Plicatoperipatus jamaicensis*) was published. This was followed by the description of three other species in three additional genera: *Peripatus swainsonae* Cockerell, 1893, *Epiperipatus lewisi* Arnett, 1961, and *Macroperipatus clarki* Arnett, 1961 (Grabham and Cockerell 1892; Grabham 1893; Arnett 1961). Jamaican onychophorans certainly raised awareness among local and visiting scientists and natural historians (e.g. Duerden 1901; Barbour 1910; Andrews 1912, 1933; Lynn 1936). But perhaps the greatest hit for the Jamaican onychophorans was the discovery of the second troglobitic velvet worm species, *Speleoperipatus spelaeus* Peck, 1975, by cave biologist Stewart B. Peck after a series of speleological expeditions to Jamaica in the 1970's. This species was described based on four specimens from Pedro Great Cave (now Pedro Cave), Clarendon Parish, one collected on December 20th, 1972 (leg., S.B. Peck), one on March 25th, 1973 (leg., R. Norton & R. Zimmerman), and two on August 17th, 1974 (leg., S.B. Peck & family) (Peck 1975a, 1975b). No specimen has been reported from Pedro Cave since the last collection in 1974, and thus, *S. spelaeus* has since been considered among the rarest animals in Jamaica.

Results and discussion

Speleological research in Jamaica has flourished in the past two decades since the founding of the Jamaican Caves Organisation (JCO) by co-author RSS. This has led to the discovery, at Swansea Cave, Saint Catherine Parish, of one specimen of a blind, depigmented velvet worm observed on February 13th, 2010 and two additional specimens photographed on November 6th, 2021(Fig. 1). These specimens remain unstudied, as no collection was conducted.

The two cave systems, Pedro and Swansea, are relatively close, separated by less than 6 km of linear distance through an area with numerous known caves (Fig. 2).

Driven by the discovery of additional specimens of blind, depigmented velvet worms in Swansea Cave by the JCO 36 years after *S. spelaeus* was last seen at Pedro Cave, and as part of ongoing research on Jamaican velvet worm diversity and systematics, a team of speleologists from Jamaica and foreign researchers returned to Pedro Cave in search of the elusive Jamaican blind velvet worm, currently listed as Critically Endangered (CE) by the IUCN (New 1996).

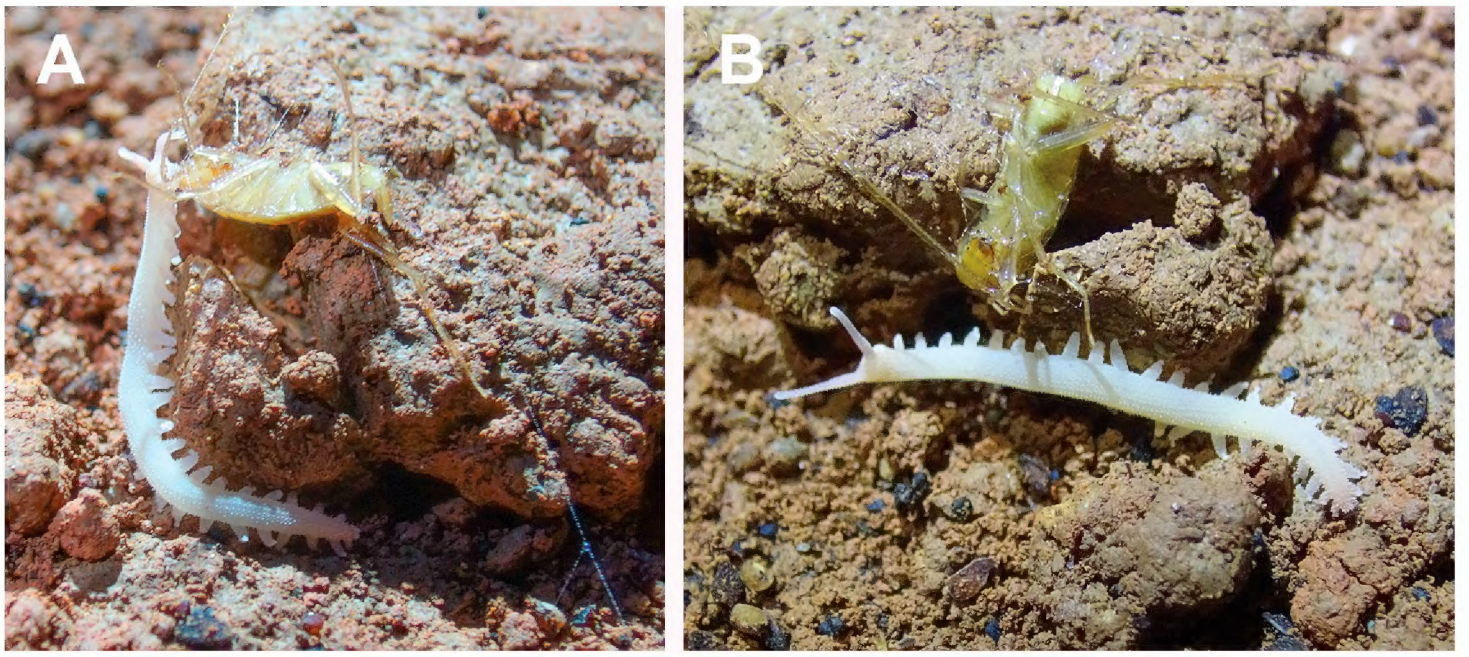

Figure 1. Swansea Cave specimen with prey (photographed on November 6th, 2021. Photos by J. Pauel (JCO).

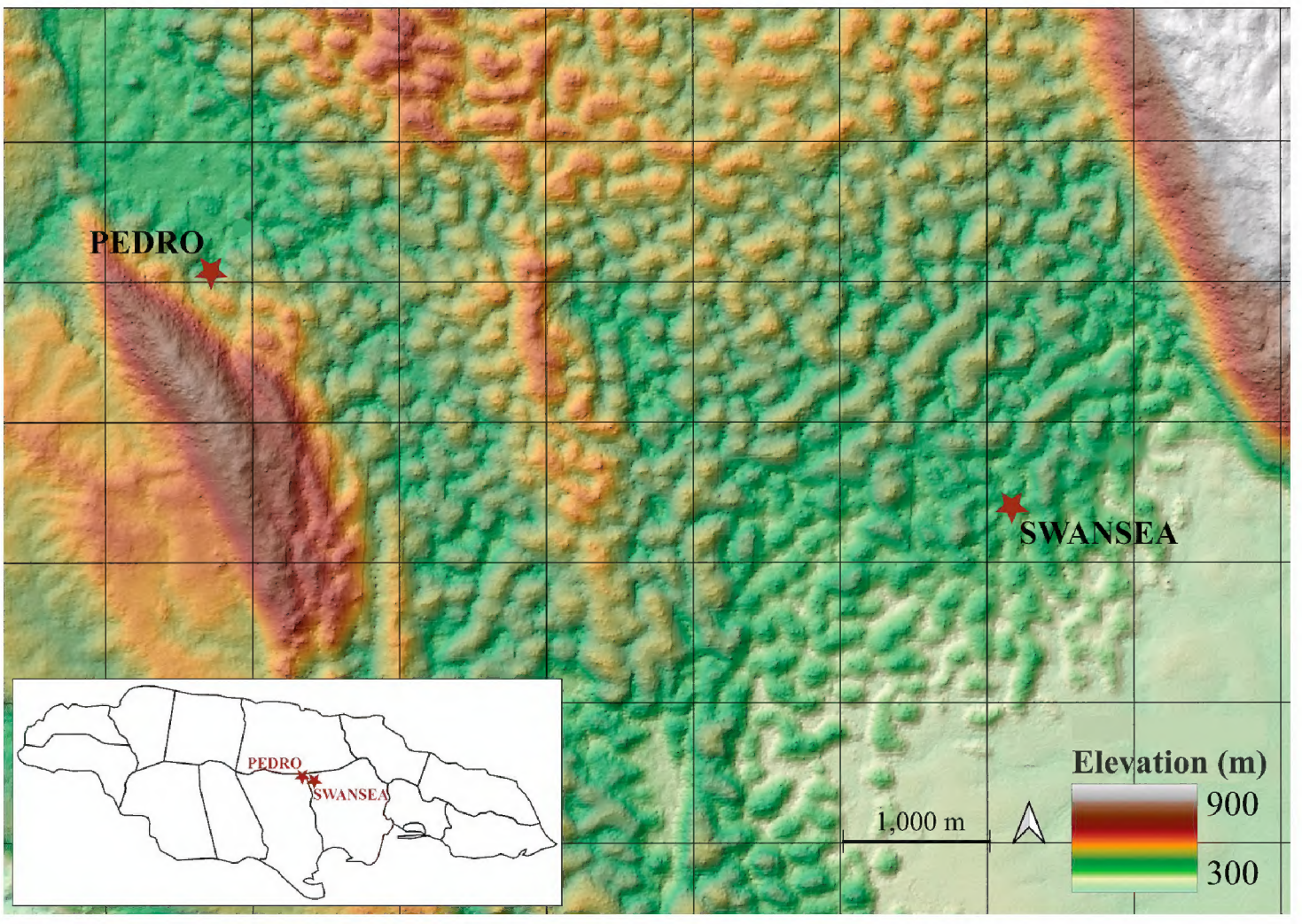

Figure 2. Map of the area from Pedro Cave to Swansea Cave.

The team of six researchers/crew explored Pedro Cave on January 18th, 2025, to assess the status of *S. spelaeus*—a species that had not been observed in this cave since 1974, and that was only known based on the four specimens from this cave studied by Peck (1975b), and by the observation of three specimens, probably

conspecific, from Swansea Cave by the JCO (Fig. 1). We searched the different sections of Pedro Cave and documented some of the fauna present in each section, which included, among other, a rare Opiliones in the family Zalmoxidae, *Ethobunus goodnighti* (Rambla, 1969), known from two specimens collected by S. B. Peck in 1968 in St. Clair Cave, St. Catherine Parish (Rambla 1969), and not documented since. The identified cave fauna includes non-adapted species, such as the Jamaican rock frog *Eleutherodactylus cundalli* Dunn, 1926 as well as some synanthropic species, such as *Oxidus gracilis* (C. L. Koch, 1847) (Myriapoda, Diplopoda, Paradoxosomatidae), abundant deep into the cave, the American cockroach *Periplaneta americana* (Linnaeus, 1758) (Insecta, Blattodea, Blattidae), as well as the cane toad *Rhinella marina* (Linnaeus, 1758) (Amphibia, Anura, Bufonidae), found ca. 200 meters from the entrance of the cave. Among the cave-adapted fauna, there were four bat species: the Jamaican fruit bat, *Artibeus jamaicensis* Leach, 1821; Leach's single leaf bat *Monophyllus redmani* Leach, 1821; the Antillean ghost-faced bat *Mormoops blainvillei* Leach, 1821; and MacLeay's mustached bat *Pteronotus macleayii* (Gray, 1839). The cave also hosts a number of arthropods, including the abundant spider *Gaucelmus cavernicola* (Petrunkevitch, 1910) (Araneae, Synotaxidae), three other spider species (including one Scytodidae, one Ctenidae, *Ctenus* cf. *catherine* Polotow & Brescovit, 2012, and one small mygalmorph), a whip-spider in the genus *Phrynus* closely resembling *P. levii* Quintero, 1981 (Amblypygi, Phrynidae), the extremely abundant cricket *Uvaroviella cavicola* Chopard, 1923 (Insecta, Orthoptera, Phalangopsidae), and an unidentified depigmented cockroach species (Fig. 3).

The Pedro Cave entrance was followed by the Belfry bifurcation and Bat Hall (Fig. 4). These areas showed abundant populations of bats, crickets, and the spider *Gaucelmus cavernicola*, although the whip-spider and ctenid spider species were also relatively abundant. *Gaucelmus cavernicola* is a common endemic Jamaican troglophile, recorded in numerous caves throughout at least ten Parishes (Peck 1975a; Gertsch 1984; Peck 1992). No velvet worms were located in these areas during this expedition or a prior exploration in 2024. A narrow passage then led to the Three Ways of the cave, where most of Peck velvet worm specimens had been located. It was in this section where several individuals of *S. spelaeus* were found walking on bat guano accumulated on top of a layer of clay (Fig. 5). Bat guano can be extremely variable, providing numerous microhabitats differentiated by fluctuating temperature, moisture, and pH (Bogdanowicz et al. 2020), and is considered one of the four cave ecosystems (Richards 2009). In the case of a predatory species like velvet worms, guano probably attracts possible prey. Five individuals were observed and photographed on or near the guano deposits with some running water from the cave roof, but the specimens were not properly measured to avoid specimen manipulation. One specimen quickly retreated into the crevices of a porose rock upon discovery, and another one buried itself in a clump of mud until it disappeared completely. This clearly indicates that the cave offers numerous hiding places for the velvet worms.

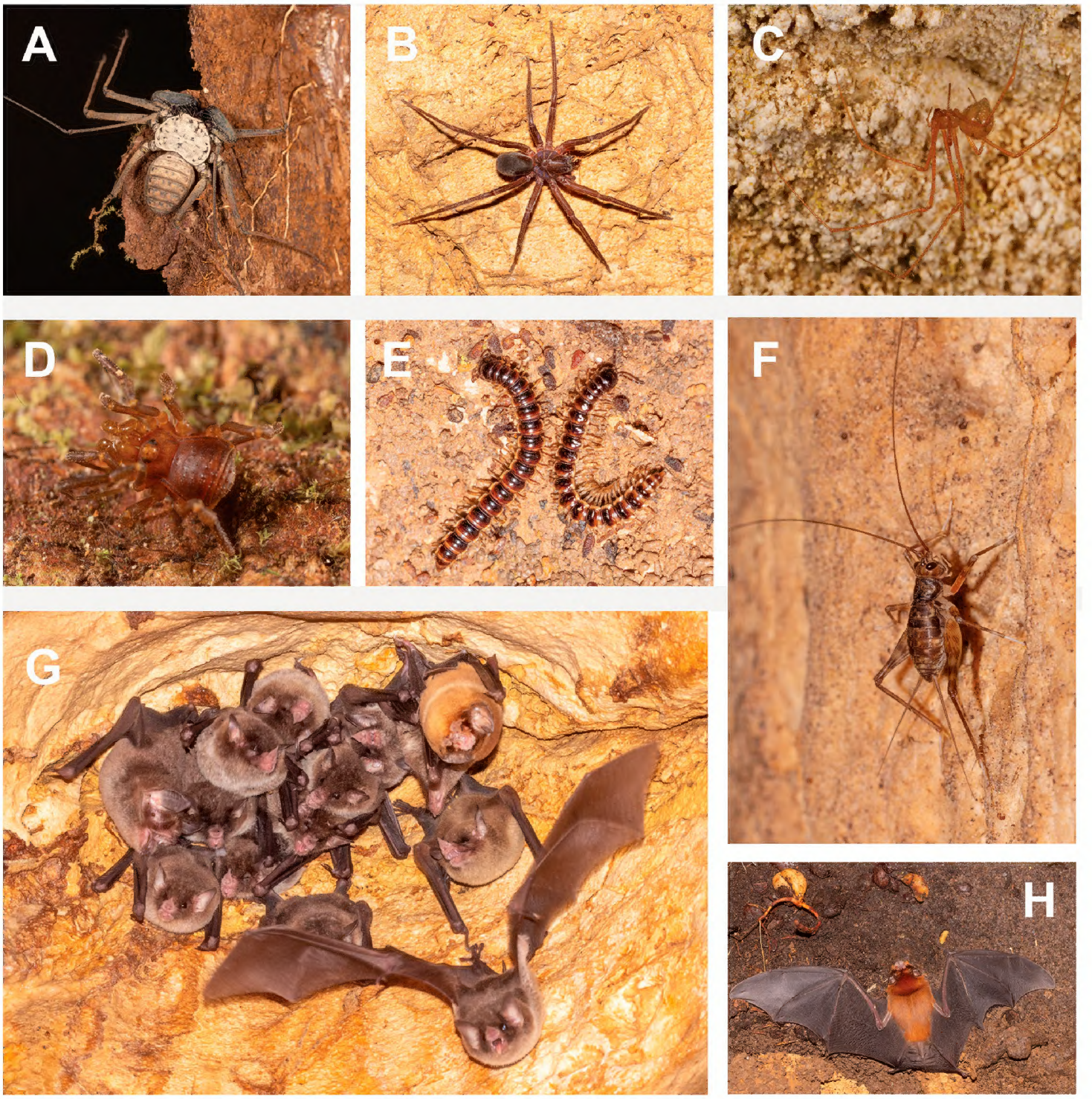

Figure 3. Examples of associated fauna found at Pedro Cave **A** *Phrynus* sp. (Chelicerata, Amblypygi) **B** *Ctenus* cf. *catherine* (Chelicerata, Araneae) **C** *Gaucelmus cavernicola* (Chelicerata, Araneae) **D** *Ethobunus goodnighti* (Chelicerata, Opiliones) **E** *Oxidus gracilis* (Myriapoda, Diplopoda) **F** *Uvaroviella cavicola* (Insecta, Orthoptera) **G** *Monophyllus redmani* and one *Mormoops blainvillei* (Mammalia, Chiroptera) **H** *Mormoops blainvillei* (Mammalia, Chiroptera). Photos **A, B, D–H** by G. Giribet; **C** by G. Hormiga.

The specimens varied in size as well as number of leg pairs and development of the last pair of legs, which could be fully developed (albeit small) to be highly reduced and pointing backwards without touching the ground while walking. From the specimens observed at Pedro Cave, three had 19 leg pairs, one had 23, and the largest individual had 22 leg pairs. The imaged Swansea individual had 21 leg pairs. However, all the specimens studied by Peck (1975b) had 22 or 23 leg pairs, with one individual showing 23 legs on the left side and 22 on the right. The three specimens with 19 leg pairs reported here require that diagnosis of the genus and the species be revised to include between 19 and 23 leg pairs (Table 1).

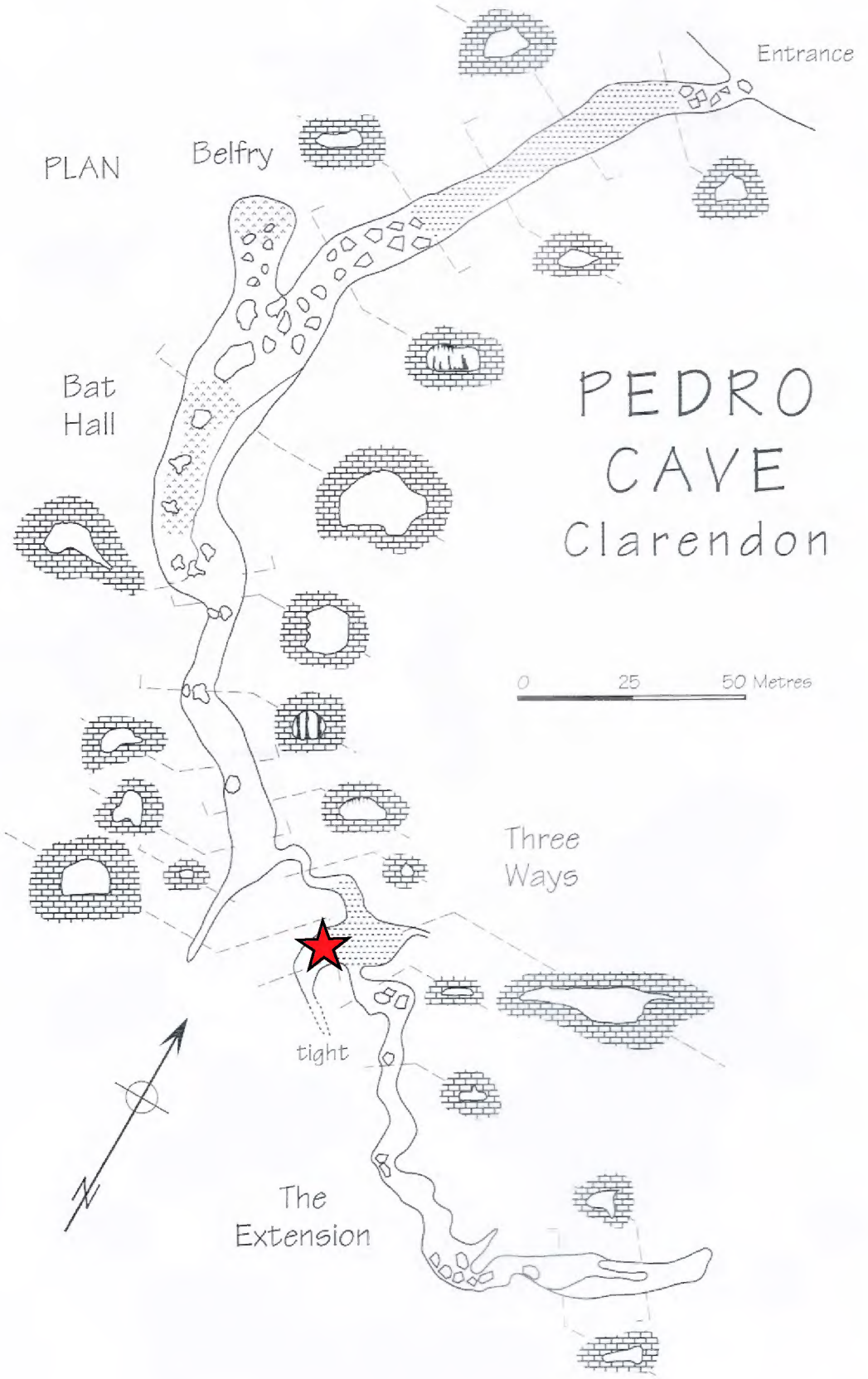

Figure 4. Map of Pedro Cave adapted from Fincham and Ashton (1967). The asterisk indicates the location of the *S. spelaeus* specimens.

Table 1. Specimens found at Pedro Cave (numbered) and Swansea Cave and leg pair numbers.

Specimen	Leg pairs
1	23 (last pair reduced)
2	19 (last pair reduced)
3	19
4	19
5	22
Swansea	21

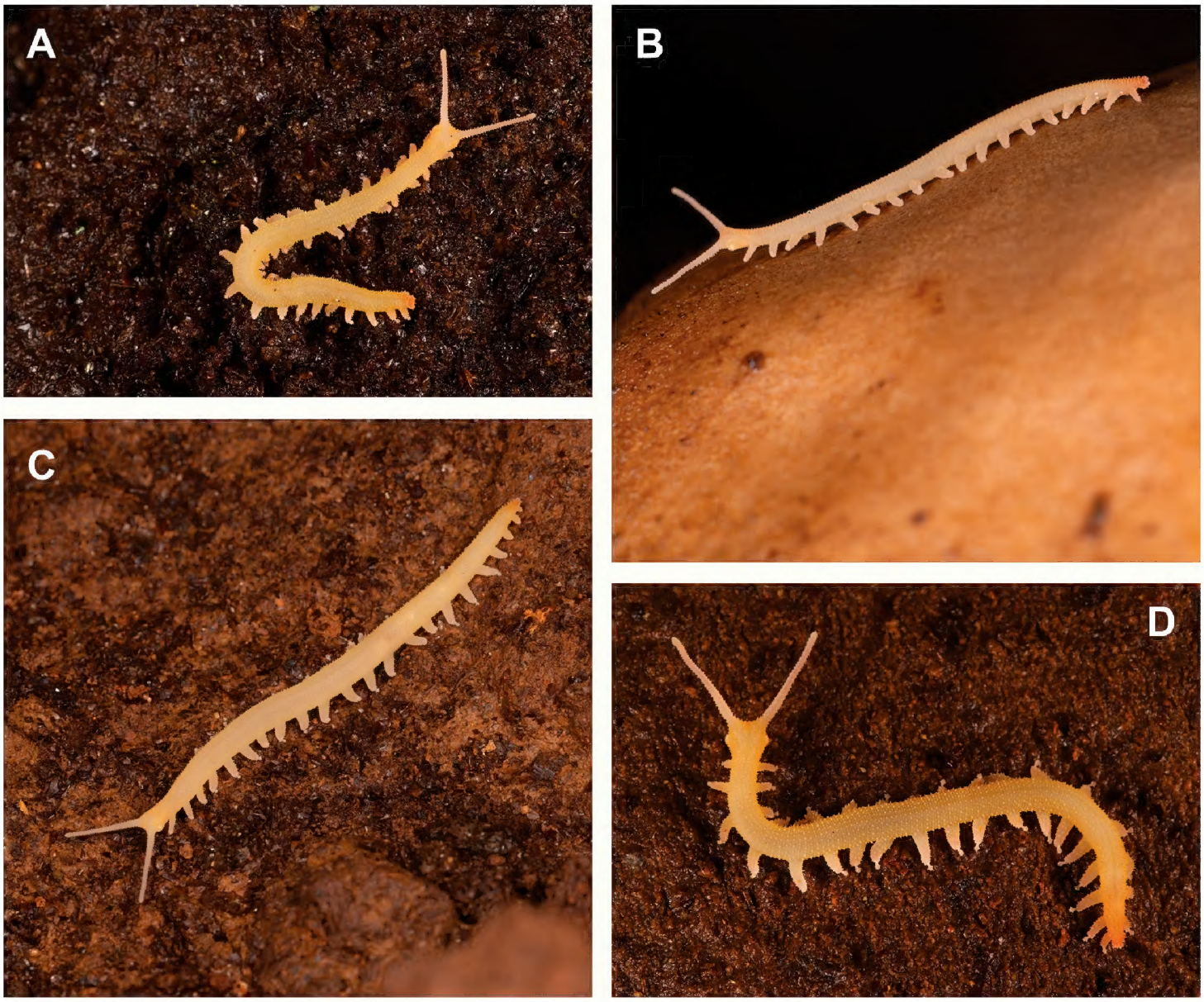

Figure 5. *Speleoperipatus spelaeus* from Pedro Cave **A** specimen 1 found on guano (23 leg pairs; note posterior diminutive legs) **B** specimen 2 (19 leg pairs) **C** specimen 5 (22 leg pairs) **D** specimen 3 (19 leg pairs). Photos **A, D** by G. Hormiga; **B, C** by G. Giribet.

Conclusion and future directions

Cave animals are often perceived as rare because they are seldom found due to the inherent difficulties of working in caves and low visitation rates, and therefore they display low detectability. The two troglobiotic velvet worm species are red-listed by the IUCN. *Speleoperipatus spelaeus* is currently considered as Critically Endangered (CE) because of its restricted habitat and the paucity of specimens known to science. However, the discovery of at least three individuals, probably conspecific, at a second location in Swansea Cave and the dedicated search at Pedro Cave resulting in the finding of five individuals in less than an hour of sampling, both suggest that the species may not be as rare as previously thought, and we expect that future work can help re-evaluate its status, Critically Endangered, as currently classified. We hope that, while continuing to apply conservation measures, this unique species can be properly evaluated for its ecology, distribution, and evolutionary history, as only then will we be able to properly understand the population size of this species and therefore its true

conservation perils. Furthermore, to better understand the significance of *Speleoperipatus spelaeus*, its distribution range, and its evolutionary origins it is imperative that the phylogenetic placement of this is species is investigated to determine what are its closest relatives and whether those are other Jamaican species or velvet worms from other areas. Phylogenomic methods using ultraconserved elements (e.g., Sato et al. 2024) offer a powerful tool to infer the phylogenetic relationships of this remarkable species.

Acknowledgements

This work was supported by the National Science Foundation (grant numbers 2154245 and 2154246) "Collaborative Research: PurSUiT: Understanding the Neotropical Velvet Worms (Onychophora, Peripatidae, Neopatida), a Cretaceous Radiation of Terrestrial Panarthropods" to GG and GH, which funded field work in Jamaica. PA, GG and GH received a research permit (Ref. #18/27) from the Jamaican National Environment and Planning Agency (NEPA) to conduct research on velvet worms and arachnids, and we show our gratitude for facilitating our research. Editor Fabio Stoch is acknowledged for his time and comments that helped improve this article. No specimen of *Speleoperipatus spelaeus* was collected during this research.

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